



New Millennium Program



# MARS MICROPROBE PROJECT

IPDT FORUM

Sarah A. Gavit  
January 29, 1997





New Millennium Program

## Agenda



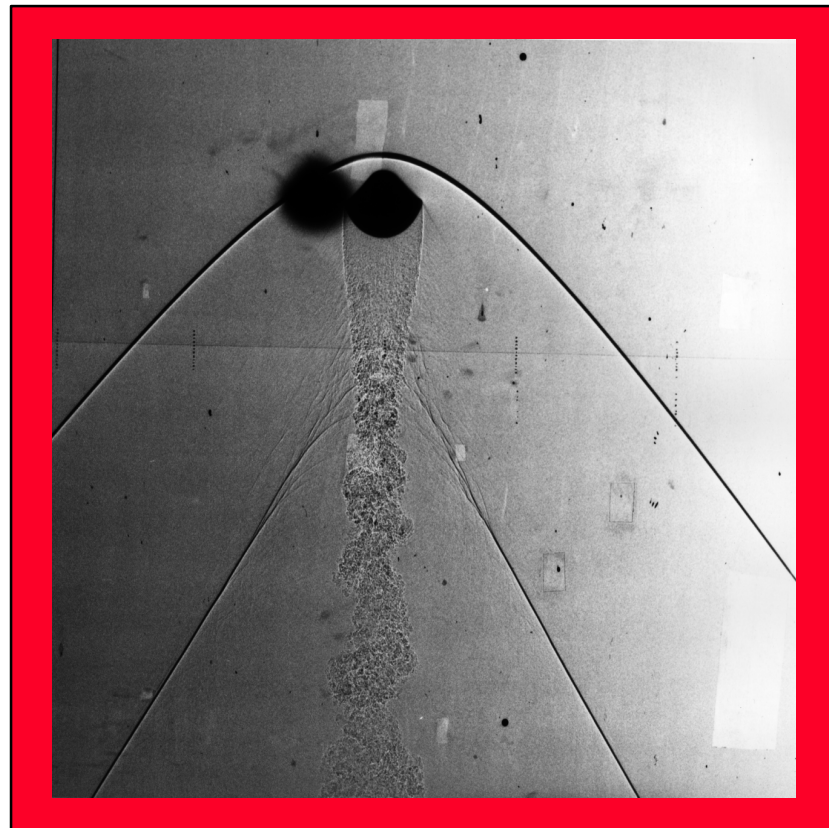
**Mission Objectives**

**Mission Overview**

**Technologies & Partners**

**Budget & Schedule**

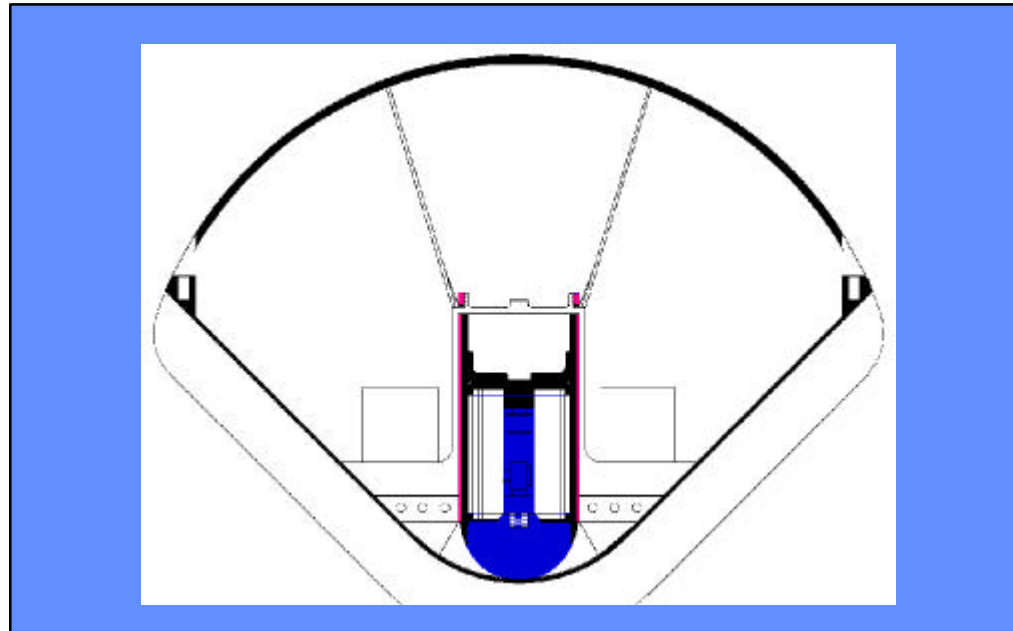
**Test Highlights**





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## Mars Microprobe Project Objectives



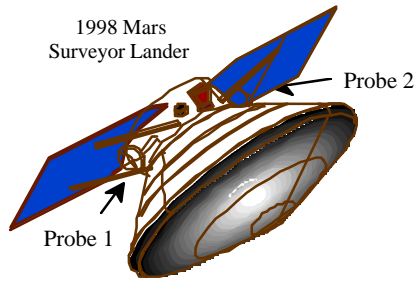
- Demonstrate key technologies which enable future network science missions
- Demonstrate a passive atmospheric entry and landing system
- Demonstrate highly integrated microelectronics which can withstand both low temperatures and high decelerations
- Demonstrate in-situ, surface and subsurface science data acquisition, and
- Provide an opportunity to collect meaningful science data



## New Millennium Program

# MARS MICROPROBE MISSION PROFILE

N M P

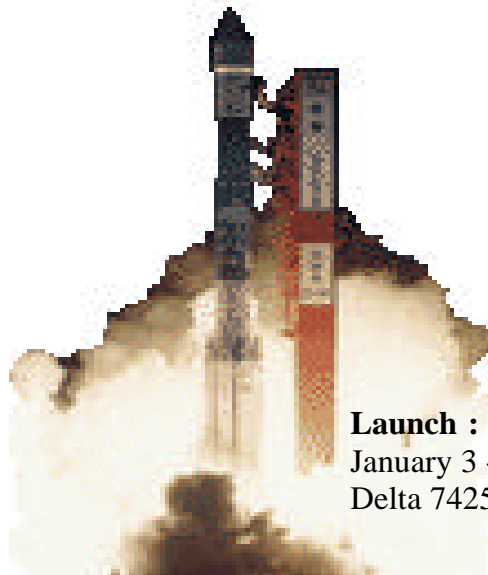
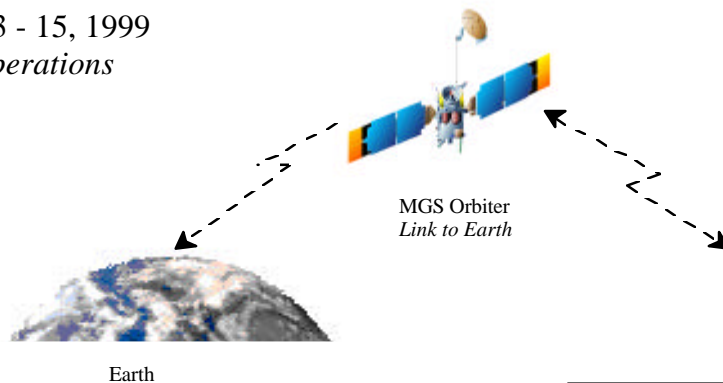


### Entry, Descent & Impact:

10 minutes from Separation to Impact  
*Passive, Single Stage System*  
*Non-Erosive Aeroshell*

### Cruise :

11 months  
Arrive December 3 - 15, 1999  
*No Microprobe Operations*



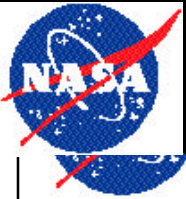
### Launch :

January 3 - 16, 1999  
Delta 7425 II Launch Vehicle

### Landed Operations:

Primary Mission: 2 Sols  
Battery Dependent Mission  
*Technology Validation*  
*Soil Collection*  
*Ice Detection*  
*Soil Conductivity*  
*Meteorological Readings*



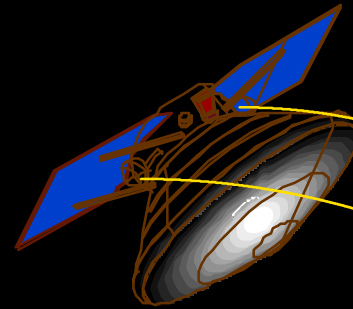


# MARS MICROPROBE

NMP

Phase

Terminal  
Phase



Mars Surveyor Lander

Microprobe

Arrival date 12/3/99 -12/15/99  
Separation - 10 min. to Impact  
Separation  $\Delta V < 0.3$  m/s  
Entry velocity = 6.9 - 7.1 km/s  
Flight path angle =  $-13.25^\circ \pm 0.4^\circ$

Microprobe:  
Landing velocity - 160 - 200 m/s  
Soil rating (S) = 3 - 17  
Landed mass  $\approx 3$  kg

Angle of Incidence  $\approx 20^\circ$

Entry Conditions:

Passive orientation  
EDI mass  $\approx 3.8$  kg  
Entry heating rate - 200 W/cm<sup>2</sup>  
Max g < 20 deceleration

Incidence

Landing Site:

$73^\circ$  -  $77^\circ$ S  
 $180^\circ$  -  $230^\circ$ W  
Ls = 256  
Altitude =  $3\text{Km} \pm 3\text{Km}$

Forebody:  
Max g < 30,000 deceleration  
Penetration depth - 0.3 to 2 m  
Lifetime - 2 days

Aftbody:  
Max g < 80,000 deceleration  
Penetration depth < 15cm

G. Powell

## Technology Demonstrations

**Non-erosive, lightweight, single-stage atmospheric entry system**

**Microtelecommunications system with programmable transceiver**

**Power microelectronics with with mixed digital/analog ASICs**

**Ultra low temperature lithium battery**

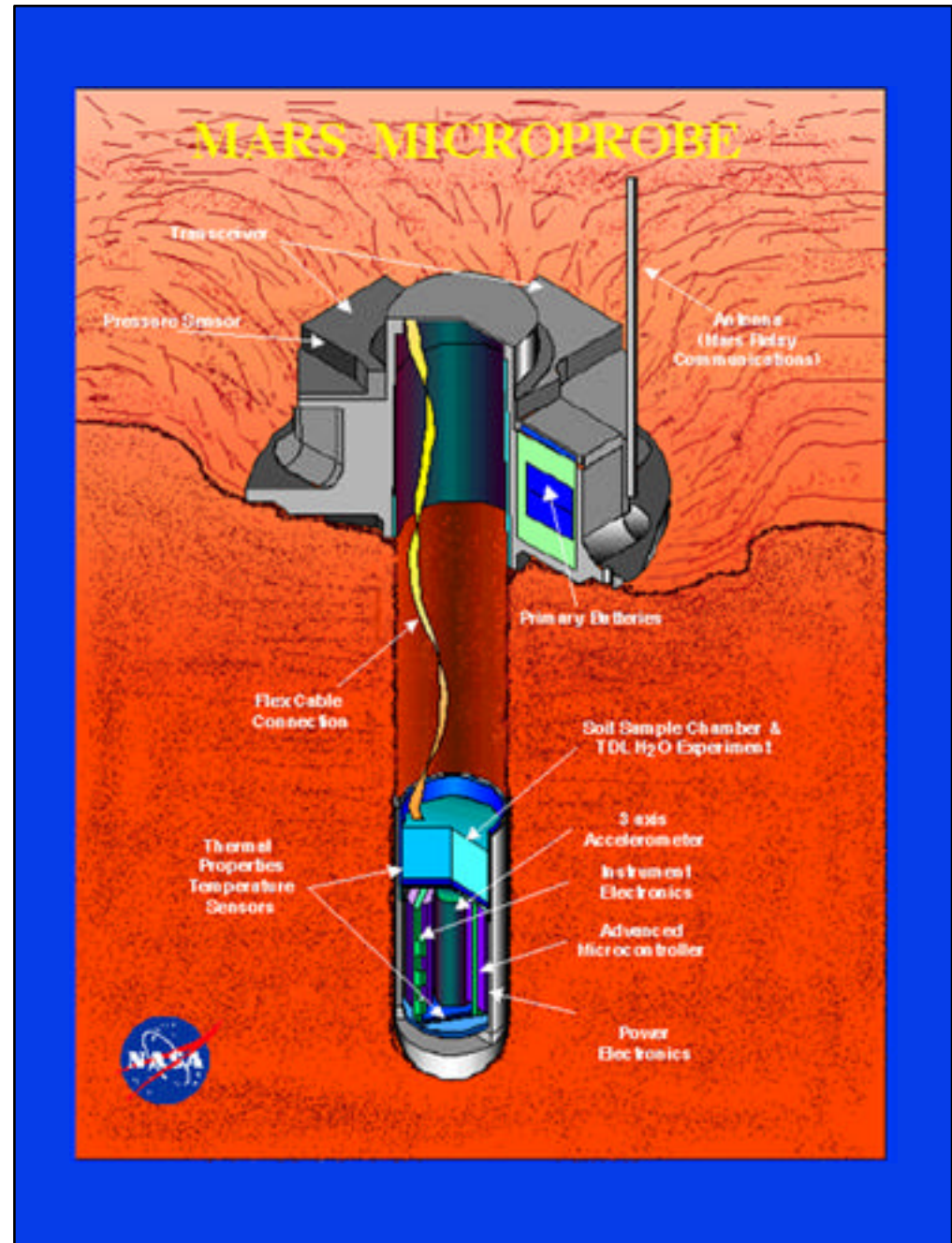
**Advanced 3D HDI microcontroller**

**Flexible interconnects for system cabling**

**Meteorological high-g pressure sensor**

**Soil conductivity high-g temperature sensor**

**Sample/water experiment**





## New Millennium Program



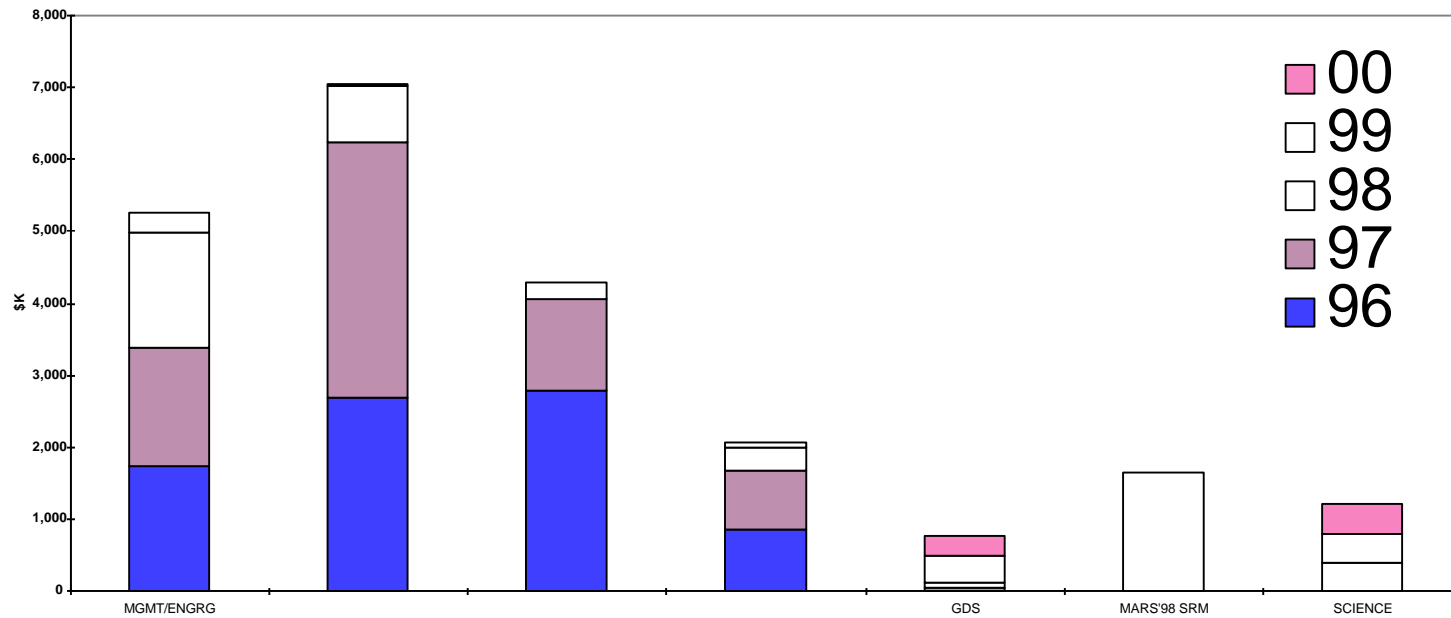
### Technologies Selected for DS2 & Team Participants\*

<u>Technology</u>	<u>Lead</u>	<u>Participants</u>
Non-erosive, lightweight, single-stage atmospheric entry system	Program Office	JPL, SNL, LRC, AMES ARA, New Mexico Tech.
Microtelecommunications system with programmable transceiver	Telecom IPDT	Atmel, JPL, Space Electronics Ohio State University, UCLA
Power microelectronics with mixed digital/analog ASICs	µelectr. IPDT	Boeing Missiles & Space
Ultra low temperature lithium battery	MAMS IPDT	JPL, Yardney, Eagle Picher
Advanced 3D HDI microcontroller	µelectr. IPDT	APL, Boeing, GE, LMA, Tech Assoc. Univ. of Tenn., Mission Research, LRC
Flexible interconnects for system cabling	MAMS IPDT	Lockheed Martin Astronautics
Meteorological high-g pressure sensor	Program Office	Nova Sensors, AMES, Stanford
Soil conductance high-g temperature sensor	Program Office	Rosemont
Sample / Water Experiment	ISIM IPDT	Caltech, JPL, AMES

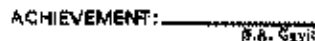
\* Lockheed Martin Electro-Optical Systems is primary industry partner for integration and test



## New Millennium Program Budget



	FY96	FY97	FY98	FY99	FY00	Total
	\$K	\$K	\$K	\$K	\$K	\$K
DS2 Project	8550	8850	4890	1700	760	24,750
SRM for Mars '98	0	0	1650	0	0	
Total			6540		760	



## New Millennium Deep-Space 2 Mars Microprobe Project Integrated Schedule

LEVEL  
2

STATUS AS OF: Jan 24, 1993

2 of 7

ACTIVITY		1995				1996				1997												1998				1999				2000																																																																																																																																																																																																																			
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6	Technology Selection							Approval																																																																																																																																																																																																																																									
7	Tech. Agreements							Negotiated					Gate 1												Gate 3																																																																																																																																																																																																																								
8	Project Reviews			BR									FR1							FR2					FR3		PR4				LAR																																																																																																																																																																																																																		
9	Mars '98 / Launch Deliverables																																																																																																																																																																																																																																																
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A-o-A	Angle-of-Attack & S/MAC
A&T	Assembly & Test
AM	Attachment Mechanism
AO	Announcement of Opportunity
CDR	Officer Design Review
CCR	Conceptual Peer Review
EM	Engineering Model

FPR	Final Peer Review
IPR	Interim Peer Review
LAR	Launch Readiness Review
MOA	Memorandum of Agreement
MR	Mark Haley Test
PDR	Preliminary Design Review
PR	Project Review

PSR	Preaching Review
SAT	Science Advisory Team
SP	System Packaging
SR	Status Review
TMM	Thermal Mass Model



## New Millennium Program Early Demonstration Tests



### Dates / Testbed

Fall 1995 to April 1996, Airplane drop in Mojave Desert

### Purpose

Provide quick turnaround, cost effective, test environment for early prototype designs

### Accomplishments

Early demonstration of penetrator fore and aftbody mechanical shape and size

Early demonstration of tether deployment system

Early demonstration of various electronic packaging and instrumentation techniques





## New Millennium Program Angle of Attack Tests



### Dates / Testbed

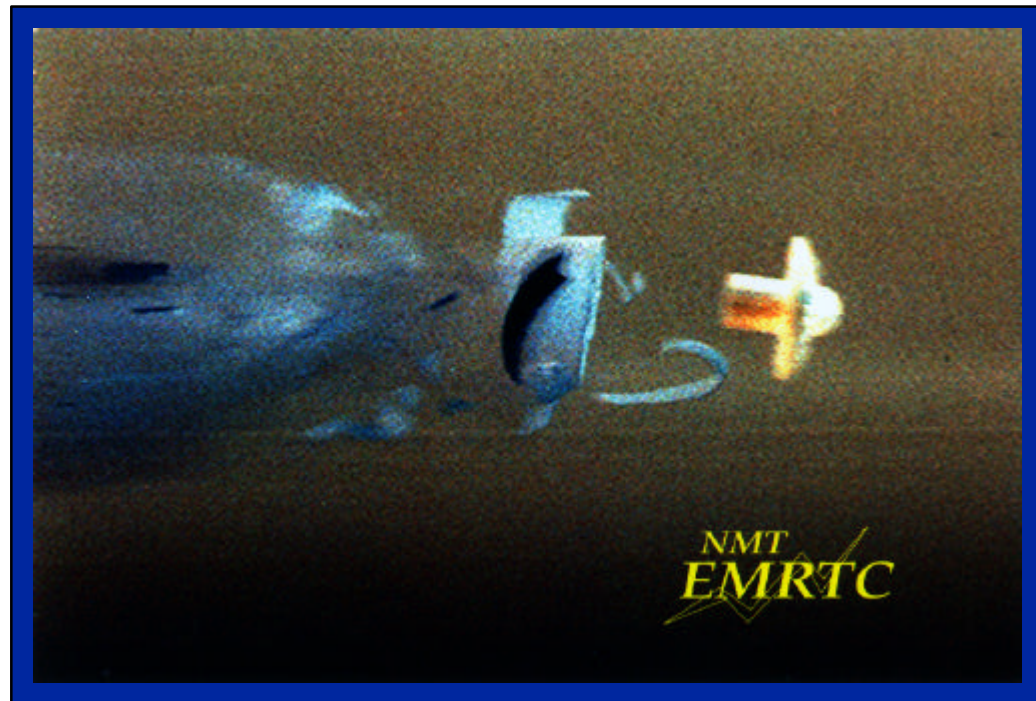
April 1996 to September 1996, Sandia Airgun at New Mexico Tech (Socorro, NM)

### Purpose

Optimize probe mechanical design for worst case impact conditions. Characterize probe impact capabilities.

### Accomplishments

Probe successfully tested to 12 degree angle-of-attack and 30 degrees angle-of-incidence. Tests included both soft and hard soil environments ( $S = 3$  to 17, soft clay to frozen soil)









### **Dates / Testbed**

September 1996 to December 1996, Sandia Airgun at New Mexico Tech (Socorro, NM)

### **Purpose**

Demonstrate mechanical engineering model design, system packaging techniques, and high risk electrical components

### **Accomplishments**

The following have been successfully demonstrated under worst case impact conditions

- Fore and aftbody mechanical design
- Forebody electronics prism
- Telecommunications crystals and pressure sensors (survival packaging dependent)
- Power electronics inductors and capacitors
- Tether deployment
- Sample collection motor (mixed results)

The following have NOT been successfully demonstrated under worst case impact conditions

- Microcontroller packaging prototype (scheduled 1/21/97)
- Sample collection motor (scheduled 1/21/97)
- Batteries packaged for high-G environment (scheduled 2/15/97)
- Antenna (continuous testing)



## New Millennium Program Entry, Descent & Impact Tests



### Arcjet Tests & Trajectory Simulations

NASA Ames completed arcjet tests on all potential aeroshell TPS material combinations during weeks of 11/4/96 and 11/11/96. Results showed somewhat better than expected performance from SIRCA/Split material which is now officially baselined

NASA Langley completed first set of high fidelity Monte Carlo trajectory simulations. Initial results show hypersonic reorientation within 50 seconds of entry and 2 sigma penetration performance



### Wind Tunnel Tests

Successfully completed transonic wind tunnel tests at correct Reynolds number at TsNiMash near Moscow in Russia 11/5/96 and 11/6/96. Results showed positive stability throughout transonic flight regime thus validating the DS2 aerodynamic design

